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How Will Sea Ice Loss Affect the Greenland Ice Sheet?

On the Puzzling Features of Greenland Ice-Core Isotopic Composition;
Copenhagen, Denmark, 26–28 October 2015



Sea ice near West Greenland in summer 2014. Credit: Kerim H. Nisancioglu

By Francesco S. R. Pausata, Allegra N. LeGrande, and William H. G. Roberts ☉ 14 March 2016

The modern cryosphere, Earth's frozen water regime, is in fast transition. Greenland ice cores show how fast these changes can be, presenting evidence of up to 15°C warming events over timescales of less than a decade. These events, called Dansgaard/Oeschger (D/O) events, are believed to be associated with rapid changes in Arctic sea ice, although the underlying mechanisms are still unclear.

The modern demise of Arctic sea ice may, in turn, instigate abrupt changes on the Greenland Ice Sheet. The Arctic Sea Ice and Greenland Ice Sheet Sensitivity (☐ [Ice2Ice](https://ice2ice.b.uib.no/) (<https://ice2ice.b.uib.no/>)☐) initiative, sponsored by the European Research Council, seeks to quantify these past rapid changes to improve our understanding of what the future may hold for the Arctic.



Iceberg near West Greenland in summer 2014. Credit: Kerim H. Nisancioglu

Twenty scientists gathered in Copenhagen as part of this initiative to discuss the most recent observational, technological, and model developments toward quantifying the mechanisms behind past climate changes in Greenland. Much of the discussion focused on the causes behind the changes in stable water isotopes recorded in ice cores. The participants discussed sources of variability for stable water isotopes and framed ways that new studies could improve understanding of modern climate.

The participants also discussed how climate models could provide insights into the relative roles of local and nonlocal processes in affecting stable water isotopes within the Greenland Ice Sheet. Presentations of modeling results showed how a change in the source or seasonality of precipitation could occur not only between glacial and modern climates but also between abrupt events.

Recent fieldwork campaigns illustrate an important role of stable isotopes in atmospheric vapor and diffusion in the final stable isotope signal in ice.

Further, indications from recent fieldwork campaigns illustrate an important role of stable isotopes in atmospheric vapor and diffusion in the final stable isotope signal in ice. This feature complicates the quantitative interpretation of ice core signals but also makes the stable ice isotope signal a more robust regional indicator of climate, speakers noted. Meeting participants agreed that to further our understanding of these relationships, we need more process-focused field and laboratory campaigns.

In addition, the participants reviewed the biggest uncertainties and challenges that arise when comparing observed and simulated isotope variations and discussed whether any additional information would be available in water with heavier isotopes of oxygen or hydrogen (e.g., d excess and ^{17}O excess).



Iceberg near West Greenland in summer 2014. Credit: Kerim H. Nisancioglu

At the end of the workshop, the participants agreed on a suite of idealized modeling experiments to simulate the isotopic signature of D/O events. Several modeling groups, using various models (the Community Earth System Model, the European Centre Hamburg Model, etc.), will run these simulations. Using a set of common boundary conditions, the different mechanisms that might give the observed stable isotope signal on Greenland can be tested and their importance formally quantified.

With this understanding of isotope signaling, we can present additional constraints on the nature of the climate changes during rapid events. The results will also shed light on what causes D/O cycles, a question that remains unanswered 30 years after their discovery in the ice record.

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